PB-240 502

WALLMARK (MUD) LAKE, CHISAGO COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center, Corvallis, Oregon
National Environmental Research Center, Las Vegas, Nevada
Minnesota Pollution Control Agency
Minnesota National Guard

January 1975

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	PB 240 502
4. TITLE AND SUBTITLE: Report on Wallmark (Mud) Lake, Chisago County, Minnesota		5. REPORT DATE: Prepared January 1975 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO.: Working Paper #146
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Pacific Northwest Environmental Research Laboratory U.S.Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO.: 1BA029 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460		13. TYPE OF REPORT AND PERIOD COVERED: Final - 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited	20. SECURITY CLASS (This page)	22. PRICE

EPA Form 2220-1 (9-73)

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REPORT
ON
WALLMARK (MUD) LAKE
CHISAGO COUNTY
MINNESOTA
EPA REGION V
WORKING PAPER No. 146

WITH THE COOPERATION OF THE
MINNESOTA POLLUTION CONTROL AGENCY
AND THE
MINNESOTA NATIONAL GUARD
JANUARY, 1975

II

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

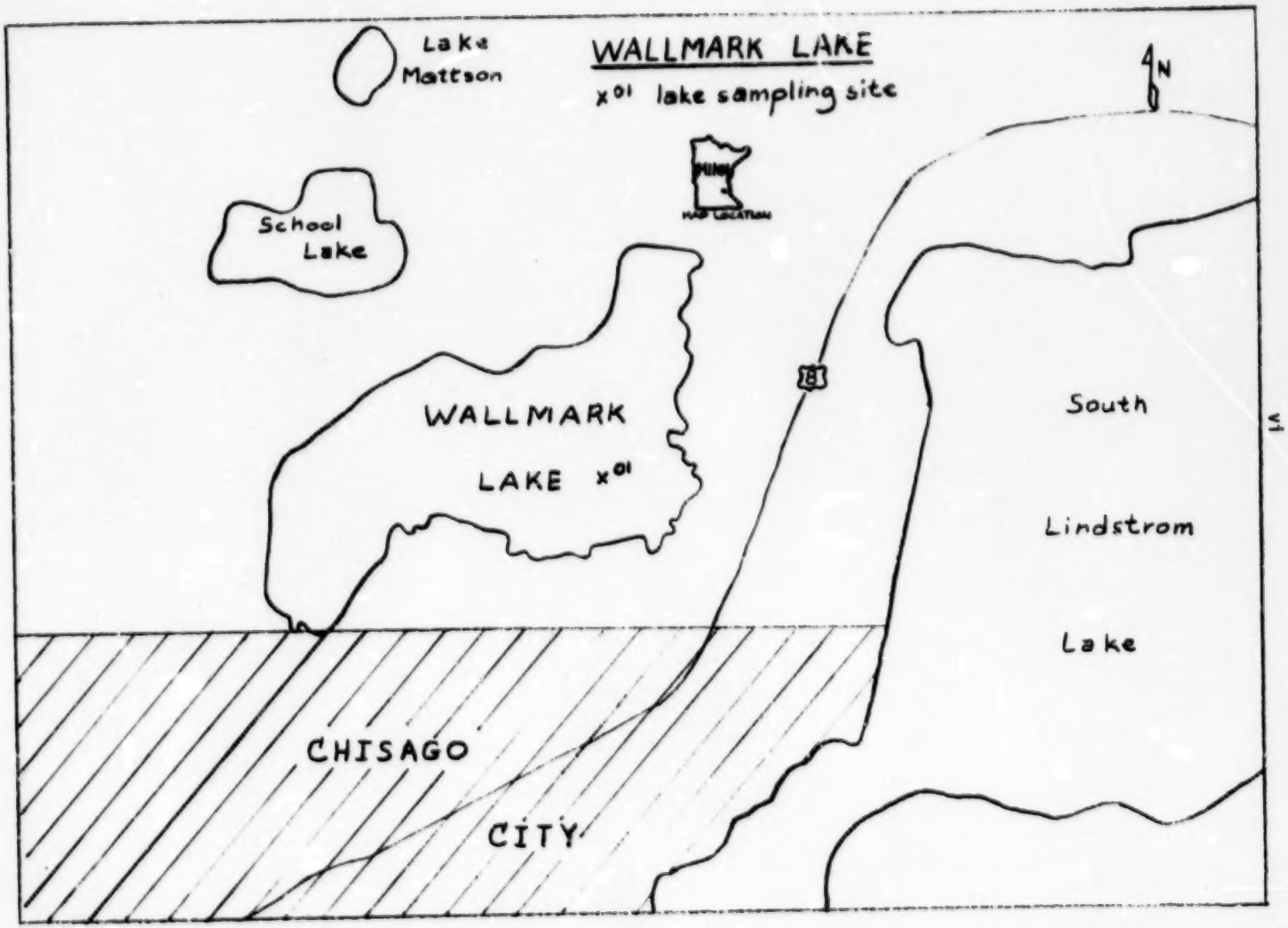
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Lake
Mattson
WALLMARK LAKE
x01 lake sampling site
N
School
Lake
MINN
MAP LOCATION
WALLMARK
LAKE x01
18
South
Lindstrom
Lake
CHISAGO
CITY

/

WALLMARK (MUD) LAKE

STORET NO. 27B7

I. INTRODUCTION

Wallmark Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

II. CONCLUSIONS

A. Trophic Condition:

Survey data show that Wallmark Lake is eutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, none had higher mean total and dissolved phosphorus, and only 6 lakes had higher mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, only one had higher mean chlorophyll a, and 66 had greater Secchi disc transparency.

Survey limnologists observed algal blooms in August and early November and noted the presence of abundant rooted aquatic vegetation.

B. Rate-Limiting Nutrient:

The algal assay results show that Wallmark Lake was nitrogen limited at the time the sample was collected. The lake data indicate nitrogen limitation at the other sampling times as well.

III. LAKE MORPHOMETRY*

A. Surface Area: 117 acres.

B. Mean Depth: unknown.

C. Maximum Depth: >8 feet.

D. Volume: unknown.

IV. PRECIPITATION

A. Year of Sampling: 27.5 inches.

B. Mean Annual: 27.3 inches.

* Anonymous, 1968.

V. LAKE WATER QUALITY SUMMARY

Wallmark Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two or more depths at one station on the lake (see map, page vi). During each visit, a single depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the last visit, a five-gallon depth-integrated sample was collected for algal assays.

The results obtained are presented in full in the Appendix, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to the Appendix.

A. Physical and chemical characteristics:

FALL VALUES

(11/05/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	4.8	4.8	4.8	4.8
Dissolved oxygen (mg/l)	10.8	10.8	10.8	10.8
Conductivity (μmhos)	360	360	360	360
pH (units)	8.4	8.4	8.4	8.4
Alkalinity (mg/l)	110	110	110	110
Total P (mg/l)	5.180	5.220	5.220	5.260
Dissolved P (mg/l)	4.780	4.820	4.820	4.860
NO_2 + NO_3 (mg/l)	0.420	0.425	0.425	0.430
Ammonia (m/gl)	0.800	0.810	0.810	0.820
		ALL VALUES		
Secchi disc (inches)	12	12	12	13

B. Biological characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
08/27/72	1. Oscillatoria	22,883
	2. Merismopedia	8,198
	3. Gleocapsa	7,207
	4. Cryptomonas	3,784
	5. Anabaena	2,342
	Other genera	5,946
	Total	50,360
11/05/72	1. Kirchneriella	13,636
	2. Rhaphidiopsis	5,090
	3. Microcystis	4,182
	4. Scenedesmus	3,636
	5. Aphanocapsa	2,364
	Other genera	15,637
	Total	44,545

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/07/72	01	187.8
08/27/72	01	327.1
11/05/72	01	231.9

* The July sample was lost in shipment.

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	1.800	1.070	34.2
0.005 P	1.805	1.070	34.6
0.010 P	1.810	1.070	36.8
0.020 P	1.820	1.070	37.9
0.050 P	1.850	1.070	31.0
0.050 P + 10.0 N	1.850	11.070	84.5
10.0 N	1.800	11.070	80.8

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates a high level of primary productivity in Wallmark Lake at the time the sample was collected. Also, the lack of significant changes in yield with increasing increments of phosphorus, until nitrogen was also added, indicates Wallmark Lake was nitrogen limited (note the markedly greater yield when only nitrogen was added).

The lake data indicate nitrogen limitation at the other sampling times as well (N/P ratios were less than 1/1).

VI. LITERATURE REVIEWED

Anonymous, 1968. Inventory of Minnesota lakes. MN Dept. of Cons., St. Paul.

Spicer, Richard A., 1960. Report on investigation of Wallmark Lake, Chisago County, Minnesota. MN Dept. of Health, Minneapolis.

VII. APPENDIX

STORET RETRIEVAL DATE 74/10/30

278701
45 23 00.0 092 53 00.0
WALLMARK LAKE
27 MINNESOTA

11EPALES
5

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/07	13 25	0000			12	305	8.90	96	0.100	0.610	2.680	2.280
	13 25	0004	20.0	9.1				92	0.110	0.550	2.830	2.460
	13 25	0008	20.0	8.6		305	8.90	93	0.060	0.590	3.040	2.430
72/08/27	11 55	0000	18.3		12	315	8.65	97	0.200	0.580	4.240	3.680
	11 55	0004	18.1	7.6		311	8.72	96	0.180	0.480	3.660	3.580
72/11/05	12 00	0000			13	360	8.40	110	0.420	0.800	5.180	4.860
	12 00	0004	4.8	10.8		360	8.40	110	0.430	0.820	5.260	4.780

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/07	13 25	0000	187.8J
72/08/27	11 55	0000	327.1J
72/11/05	12 00	0000	231.9J

J VALUE KNOWN TO BE IN ERROR